



SMEX Fleet Operations System



Presented By:

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Fleet Integration Team includes:

NASA – GMSEC, NASA – SSMO

Emergent Space Technologies, Inc.

Honeywell Technology Solutions, Inc.

L-3 Storm Control Systems

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Purpose



- **Demonstrate Fleet and Constellation Operations For Future Missions**
- **Facilitate Rapid Insertion of New Mission Services Technologies**
 - GMSEC information bus for plug-and-play modularity/interoperability
 - Ongoing SMEX missions serve as a proving ground or live test bed
- **Demonstrate Potential for Mission Operations Cost Reductions**
 - Reduced hardware and software maintenance costs
 - Consolidate legacy systems and reduce the number of external interfaces
 - Reduce costs of adding additional SMEX missions
 - Minimize hardware obsolescence
 - Reduced Operations Costs
 - Automation of, and university support for, routine operations



GMSEC System Concept



- Standardized Interfaces (not components)
 - COTS or in-house tools should have the same key interface definitions (or functionally similar)
 - Use Meta-Languages where appropriate {XML, WSDL}
 - Goal is to allow for plug-and-play modules that can be integrated quickly
- Middleware
 - Provides message-based communications services on a GMSEC “software bus”
 - Publish / subscribe, point-to-point, file transfer
 - Makes it much easier to add new tools, reduce integration efforts
- User Choices
 - Not limiting tool selection to one that fits all
 - Want to give users a choice of T&C systems, flight dynamic systems, etc.
- GMSEC “Owns” the Architecture and Interfaces



Current Configuration

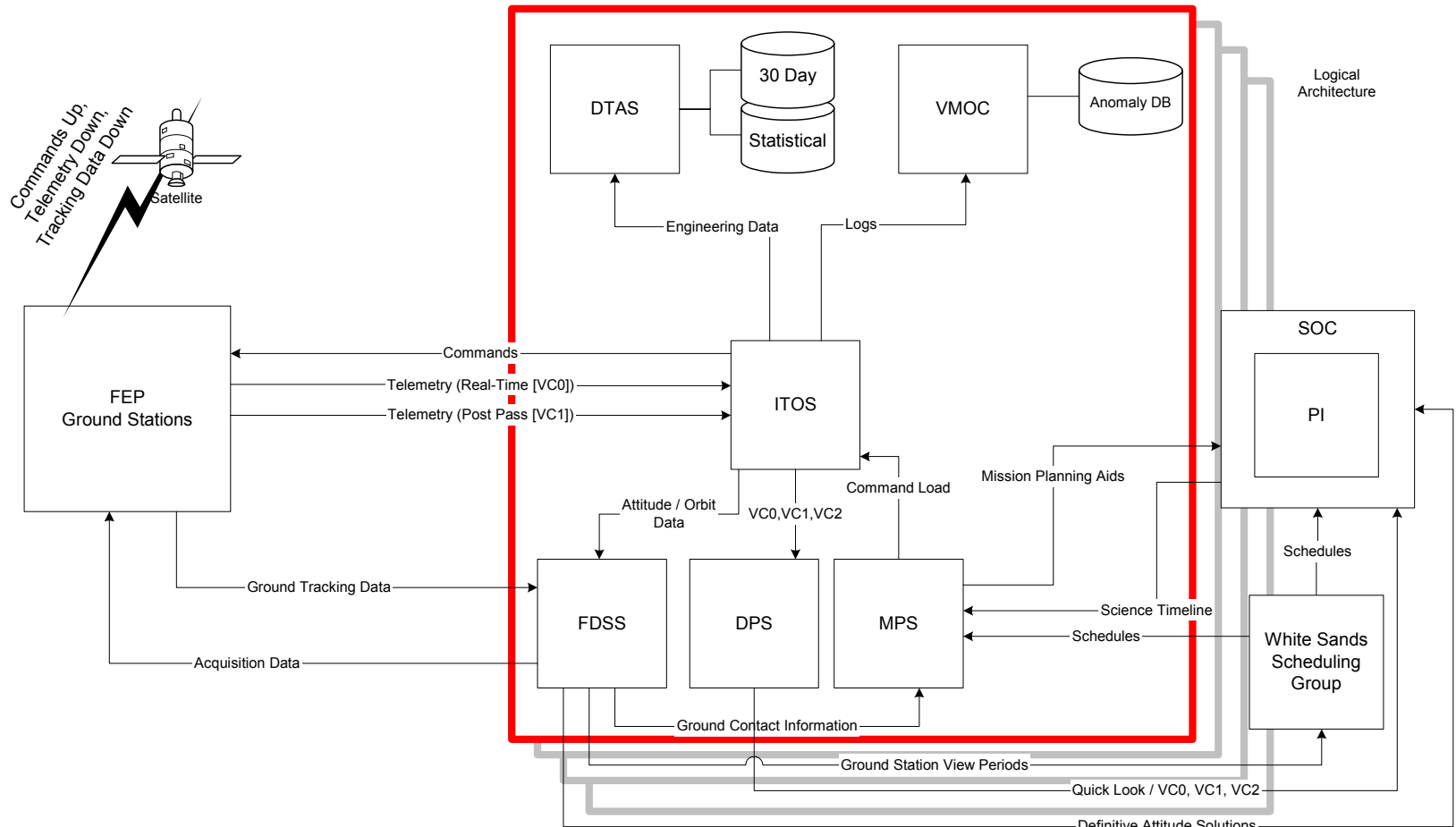


- **Six SMEX satellites currently being operated**
 - SWAS and TRACE; GSFC prime
 - SAMPEX and WIRE; Bowie State prime
 - FAST and RHESSI; Berkeley prime; GSFC future backup
 - GSFC and Bowie State are reciprocating backup facilities
- **SMEX has integrated FDF and DPS into the MOC**
- **Mission operation systems are legacy GOTS components**
 - Each mission requires multiple systems and interfaces for support
 - Each satellite has (see diagram on next slide):

<ul style="list-style-type: none">▪ ITOS T&C System▪ Planning System▪ Flight Dynamics System	<ul style="list-style-type: none">▪ Early Warning / Alarm System▪ Automation scripts▪ Data Processing System
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Current SMEX MOC Context Diagram



Single Mission System

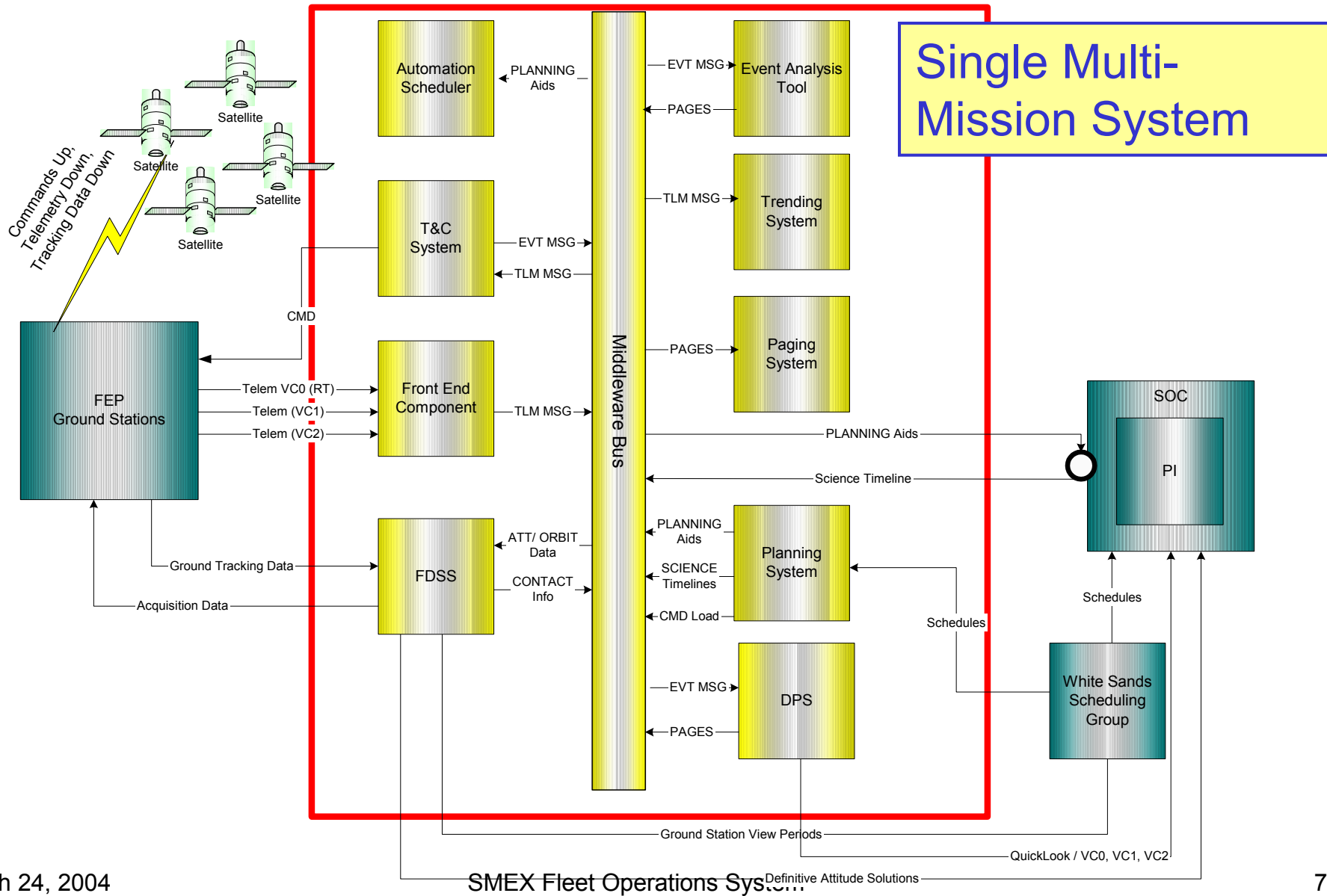


Fleet Operations Configuration



- **Built upon GMSEC architectural and messaging standards**
 - Utilizing full capabilities of GMSEC messages, incl. Telemetry, Flight Dynamics products, Scheduling products
 - Validating GMSEC messages in a Fleet environment
 - Working with GMSEC to develop message standards for Fleet configurations
- **Fleet Configuration**
 - L3 InControl-NG Multi-Satellite T&C system
 - L3 Multi-Satellite Archiving and Trending System
 - Fleet capable planning system
 - Fleet capable flight dynamics system
 - Rule-based Automation (Criteria Action Table)
 - Adopting new security policies (e.g. dynamic user authorization, system privilege logging)
- **End Result - System Consolidation**

Fleet Operations Context Diagram





L3 InControl-NG COTS T&C




- **Multi-Spacecraft and Ground Operations Management:**
 - Multiple bus and ground support via database configurability
 - Dynamic fleet view GUI's,
 - Off the shelf fleet capability
- **Procedure Platform**
 - Control of ground assets integrated into satellite operations procedures
 - Scheduling and trigger based activities to reduce workload
 - Support for native (ITOS) STOL procedures
- **Archive:**
 - Raw archives, processed value (including statistical)
 - System activity log, Plotting
- **Commercial and Fleet Installations**
 - INMARSAT; 15 satellites, 1 operator per shift
 - UK MOD SkyNet; future mission, 11 satellites
 - Astrium (In-house test, Amazonas and Hispasat), Thaicom (iPSTAR), all future launch



Phase Objectives



- **Implementing the SMEX Fleet Operations Center (FOC) in 4 phases, where each Phase successfully ends with a capability demonstration**
- **Phase 1 : March 2004** 
 - Live and Playback Telemetry for WIRE, SAMPEX, SWAS, TRACE
- **Phase 2 : June 2004**
 - Commanding for WIRE, SAMPEX, SWAS, TRACE
 - Demonstrating Commanding via Simulator
 - L3 Solaris GMSEC Bus support for Telemetry
 - Archiving, Trending
- **Phase 3 and 4 : August / October 2004**
 - Mission planning, command load generation, and automation
 - PI (EOF), FDF and other external interfaces
 - System Checkout and Parallel Operations
 - Telemetry and Commanding for FAST and RHESSI
- **Full database and system validation prior to live operations**



NASA Benefits



- **SMEX Fleet Ops effort will serve as a proof of concept for GMSEC in operations**
 - COTS / GOTS selection
 - Component interoperability and automation through messaging and communication standards
- **Technology and Operations Concept demonstrations for multi-satellite operations (Constellations and Formations)**
 - MMS, MAXIM, Stellar Imager, LISA, etc.
- **Technology and Operations Concept demonstrations for Lunar explorations**
 - T&C of multiple systems: satellites, robotic explorers, bases
- **Coordinates Interfaces between Space Sciences and Earth Sciences Directorates**



Current Status



- **Approval from Code 297 for GMSEC implementation**
- **InControl-NG (ICNG) T&C system processing concurrent fleet telemetry streams**
 - Fleet consists of SWAS, TRACE, WIRE, SAMPEX
 - L3 ported mission databases and operator consoles
 - Alarms, Warning, Event (AWE) Displays
 - Out Of Limit (OOL) Displays
 - Alpha-Numeric Displays (AND)
 - Plotting Capabilities
 - Demo to Chuck Holmes/HQ
- **Porting the command databases; adding COP-1 support in ICNG**
- **Defining a Fleet Flight Dynamics concept**
- **Evaluating L3's Trending and Planning Capabilities**



Additional Investigations FY04



- **Explore Operations Concepts for Fleets**
 - Flight Dynamics
 - Fleet Mission Planning
 - PI Integration
 - Spacecraft / Ground Communication Interfaces
- **Encourage Technology and Operations Concept demonstrations for university supported mission operations**
 - Universities provide low cost operators while training the future workforce
 - NASA provides deep engineering experience for anomaly resolution, trending and analysis, etc.
- **Foster Technology and Operations Concepts for secure remote operations**
 - University students, Principal Investigators, remote operators/engineers
 - Develop procedures for dealing with tightening security measures



ITOS PAGES



DSTLM PAGE

GMT: 04-083-15:31:34.8

Pkt 2 Time

WRAP M

TOTAL

NEW #

PREV #

*** EVEN

PKTS A

DUMPS

cc_tableops

** SCS TABLE OPERATIONS **

Page = TABLEOPS

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master

MASTER-PAGE ** TRACE S/C OVERVIEW **

PKT01: 083-15:31:01 PKTCNTS: 1817 GMT: 04-083-15:31:03

<p>**** POWER OV ****</p> <p>SA CURR A 4.74 A</p> <p>SA CURR B 4.46 A</p> <p>SHNT CURR 4.19 A</p> <p>BATT RELAY A ON</p> <p>BATT RELAY B ON</p> <p>BATT SOC 100.0 %</p> <p>BATT CURR 0.06 A</p> <p>BATT VOLT 31.3 V</p> <p>SC BUS V 31.3 V</p> <p>ESS BUS I 3.29 A</p> <p>*** CONTROLLERS ***</p> <p>V/T ON LVL 4</p> <p>AHI ON C/D 1</p> <p>CC ON TC C100</p> <p>OV ON OI ON</p> <p>SOC ON SH ON</p> <p>TRKL CHG RELAYFF</p> <p>*** LIMIT CHECKER ***</p> <p>LC STATE ACTIVE</p>	<p>*** RF STATUS ***</p> <p>RCVR STATUS LOCK</p> <p>CDU STATUS LOCK</p> <p>RCVR AGC -74.</p> <p>BIT RATE 2.25M</p> <p>VC0 RATE 32K</p> <p>ENCODING CONV</p> <p>*** TASK * PASS/FAIL</p> <p>FR ACPT 1 0</p> <p>CI CMD 90 0</p> <p>ATS LOD 60 0</p> <p>SM CMD 118 0</p> <p>*** TABLE OPS ***</p> <p>OPS STATE INACT</p> <p>SELCTD TBL ID 64</p> <p>CHECKSUM ENABLED</p> <p>*** MS STATUS ***</p> <p>MEM SCRUB ENABLE</p>	<p>*** SAFEHOLD OV **</p> <p>ACE SAFEHOLD OFF</p> <p>ACS S/W SH FALS</p> <p>SH PLS TOGGL TRUE</p> <p>SH PLS ENABL TRUE</p> <p>DEFAULT SH OFF</p> <p>*** ACS FLAGS ***</p> <p>ECLIPSE OFF</p> <p>LUNAR OCC DISA</p> <p>*** SCS S/W OV ***</p> <p>S/W MODE NORM</p> <p>WARM RESTARTS 0</p> <p>COLD RESTARTS 1</p> <p>WRM/CLD FLG COLD</p> <p>*** SCP STATUS ***</p> <p>ATP STATE EXECU</p> <p>CURR ATS ATSA</p> <p>ATP CMD CNT 51</p>	<p>**** ACS OV ****</p> <p>ACS S/W MODE SCIE</p> <p>CSS PRES TRUE</p> <p>DSS PRES TRUE</p> <p>FINE SUNPNT TRUE</p> <p>*** REACTN WHLS **</p> <p>RW A ON 20.3 rps</p> <p>RW B ON 20.3 rps</p> <p>RW C ON 20.6 rps</p> <p>RW Y ON 20.6 rps</p> <p>*** TRQ RODS ****</p> <p>TR X -0.18 mA</p> <p>TR Y 1.77 mA</p> <p>TR Z 1.65 mA</p> <p>***** GYROS *****</p> <p>GY X 4.8e-05 dg/s</p> <p>GY Y -5.3e-05 dg/s</p> <p>GY Z 6.1e-05 dg/s</p>	<p>*** INST PWR DIS ***</p> <p>NEB STAT ON 1.006 A</p> <p>DPU STAT ON 0.937 A</p> <p>INST SRV ON 0.067 A</p> <p>CCD ON TEMP -58.3 C</p> <p>***** INST CC *****</p> <p>MODE 00</p> <p>SEQUENCE ID 135C</p> <p>SEQ STATUS 8000</p> <p>SEQ # 1 of 1</p> <p>CC CNT 044510</p> <p>SERIAL INTRFC ERR 00</p> <p>**** INST DHC ****</p> <p>DHC STATUS 48</p> <p>DHC ERROR 3A80</p> <p>*** MECHANISMS ***</p> <p>STATE ON 0.004 mA</p> <p>+15V 14.99 BUSY 4</p>
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INCONTROL NG PAGES



InControl-NextGeneration - Control Frame

File Displays Users C:\InControl-NG\InControl-NG-Data\SMEX-Data-1.0.0.0b2\unscopedData\StormView-config\SV\AND\SAMPEX\master.and

InControl-NextGeneration - Fleet Frame_1

File Edit Acknowledge Tools

Time	Source	User ID	Type	Application	Message	ACK
2004/03/17 14:33:55	SAMPEX	admin	SEC	SecurityService	admin acquired control token	
2004/03/17 14:34:02	SAMPEX	admin	SCH	DemoSchedule	Schedule DemoSchedule version 1.0.0.0 brought	
2004/03/17 14:34:52	SAMPEX	admin	PRC	demo_features - 1	Procedure demo_features - 1 beginning execution.	
2004/03/17 14:37:35	SMEX	admin	USR	Awe Display	MNUWU2 violated YH limit value=100.2	

Task Status Display

File Edit Schedule Status

Start Time	Complete Time	Source	Task	Activity	Approval	State	Type
2004/06/15 11:59:00	2004/06/15 12:00:32	SAMPEX	ResetBypassTimer	ResetBypassTimer	true	ScheduledTask	
2004/06/15 11:59:00	2004/06/15 11:59:02	SAMPEX	ResetBypassTimer	Generate AWE		ScheduledAWE	
2004/06/15 12:00:02	2004/06/15 12:00:32	SAMPEX	ResetBypassTimer	ResetBypass		ScheduledProc	
2004/06/18 03:15:00	2004/06/18 03:17:00	SAMPEX	EsaBlinding	EsaBlinding	true	ScheduledTask	
2004/06/18 03:15:00	2004/06/18 03:17:00	SAMPEX	EsaBlinding	Generate AWE		ScheduledAWE	

Fleet Status View

SMPX admin SWAS None TRAC None WIRE None

OOL Display

File Edit Acknowledge Limits

Time	Source	Parameter	Name	Value	CWD	Units	Violated Limit	ACK

Alarm: Critical:0 Warning:0

SMEX

admin SMEX System Administrator